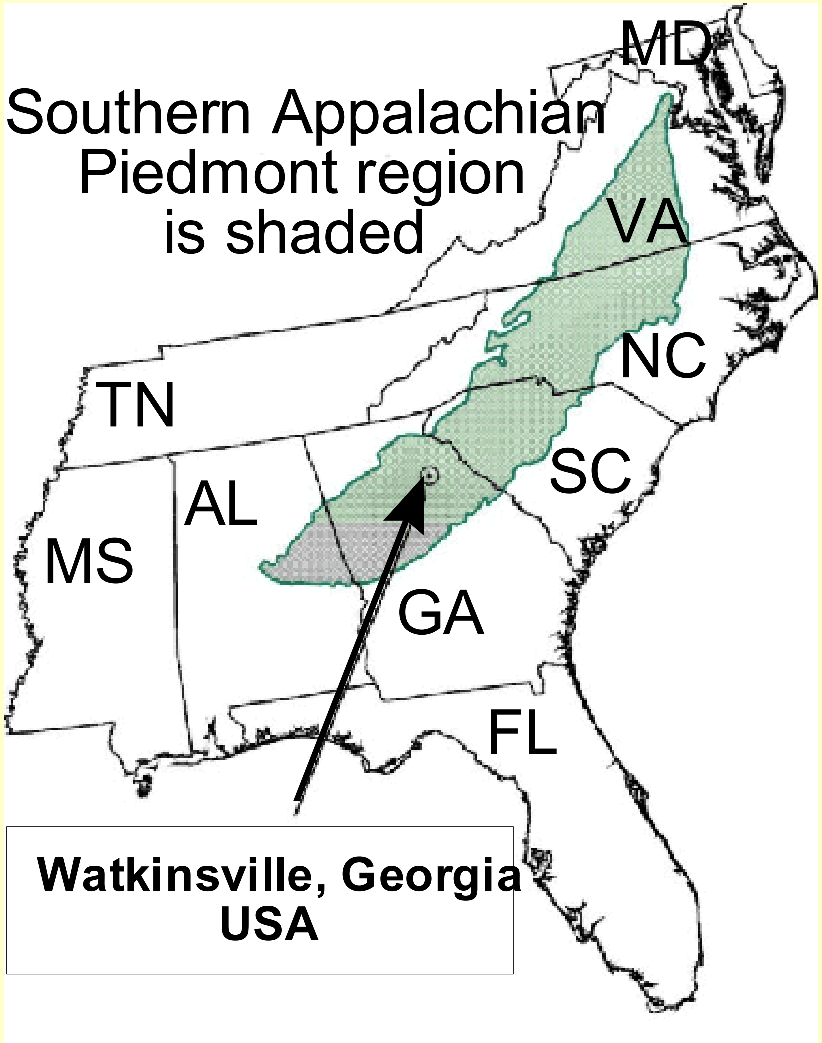
Soil Responses under Integrated Crop and Livestock Production



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Rationale

- ✓ Integration of crops and livestock could provide benefits to production and the environment
- ✓ Soil organic matter is a critical component in maintaining soil quality, through its interactions with many biological, chemical, and physical processes in soil
- ✓ Permanent pastures are known to improve soil organic C and N, but are perceived to have compaction problems
- ✓ Cropping systems in rotation with pastures have not been evaluated in detail, especially with conservation tillage

Objective

✓ Quantify soil biochemical and physical responses to three management factors:

- Tillage
  - (a) conventional tillage (CT)
  - (b) no tillage (NT)
- Cropping system
  - (a) summer grain – winter cover crop (SGWC)
  - (b) winter grain – summer cover crop (WGSC)
- Cover crop management
  - (a) unutilized
  - (b) grazed by cattle

Hypotheses

- ✓ Cropping system:
  - ***Soil*** more compacted with grazing in winter
- ✓ Cover crop:
  - ***Soil biochemical*** properties better with than without grazing initially, but reversed later?...
  - ***Soil physical*** properties poorer with than without grazing
- ✓ Tillage: *(Focus of this presentation)*
  - ***Soil biochemical*** properties better with NT than CT
  - ***Soil physical*** properties poorer with NT than CT

Methods

- ✓ Set of 18 paddocks (0.7-ha each) previously in tall fescue for 20 yr on Cecil sandy loam
- ✓ 4 replications of 8 treatments after paddocks split into grazed (0.5 ha) and ungrazed (0.2 ha) areas
- ✓ Soil collected (4-cm diam) from composite of 8 (grazed) or 5 cores (ungrazed)
  - Initiation (May 2002)
  - End of Year 1 (Nov/Dec 2002)
  - End of Year 2 (Nov/Dec 2003)
  - End of Year 3 (Nov/Dec 2004)

Methods

Methods

Experimental design

Tillage

X

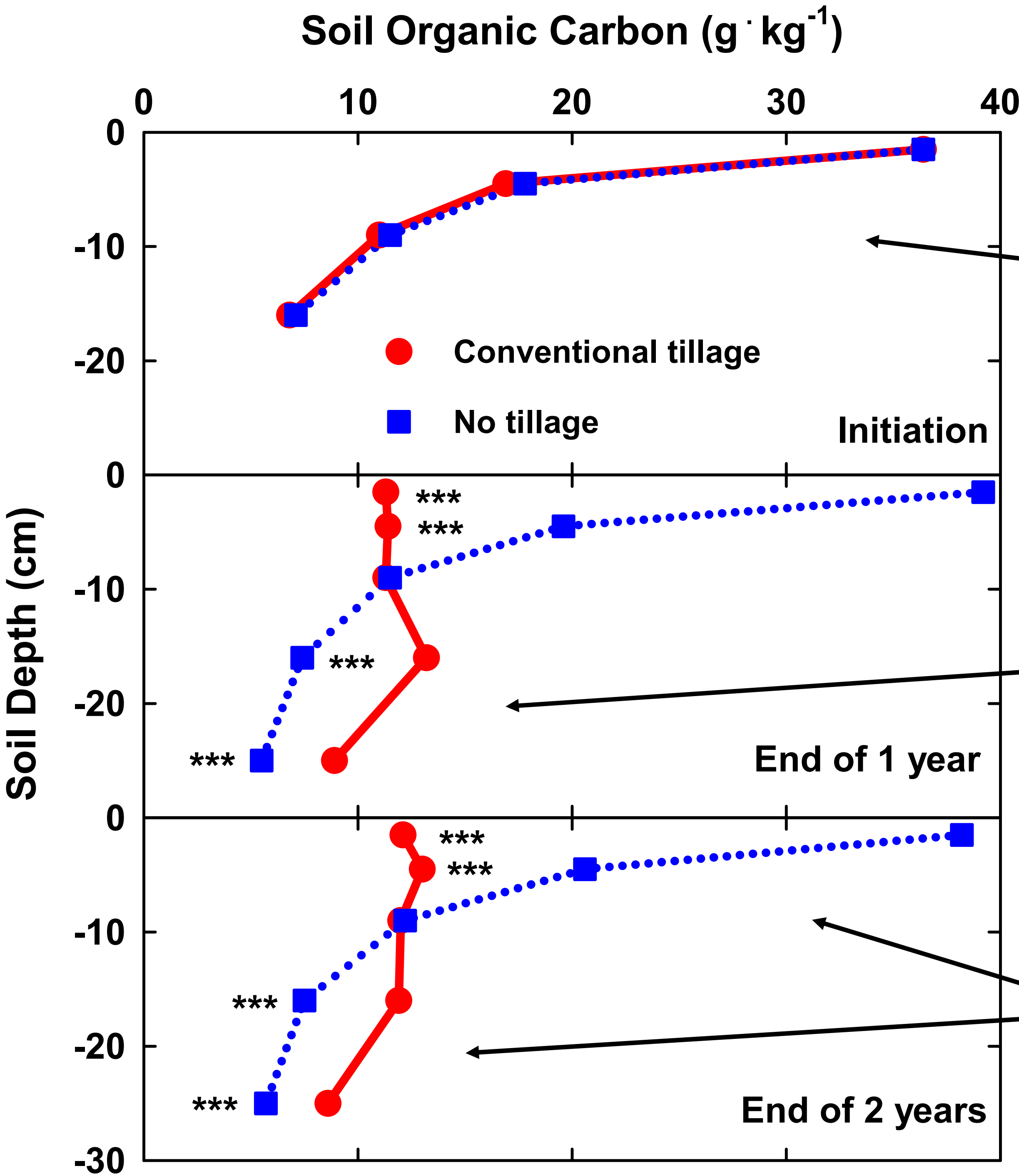
Cropping System

X

Cover Crop Utilization

Methods

- ✓ Total organic C and N (dry combustion)
- ✓ Soil microbial biomass C (chloroform fumigation-incubation)
- ✓ Soil bulk density (weight-volume of cores)
- ✓ Penetration resistance (2-kg impact penetrometer)
- ✓ Soil water content (time-domain reflectrometry)
- ✓ Water infiltration (0.3-m diam ring, intake during 1 hr)
- ✓ Mean-weight diameter of water-stable aggregates (screens with 1, 0.25, 0.05-mm openings oscillated in water for 10 minutes)

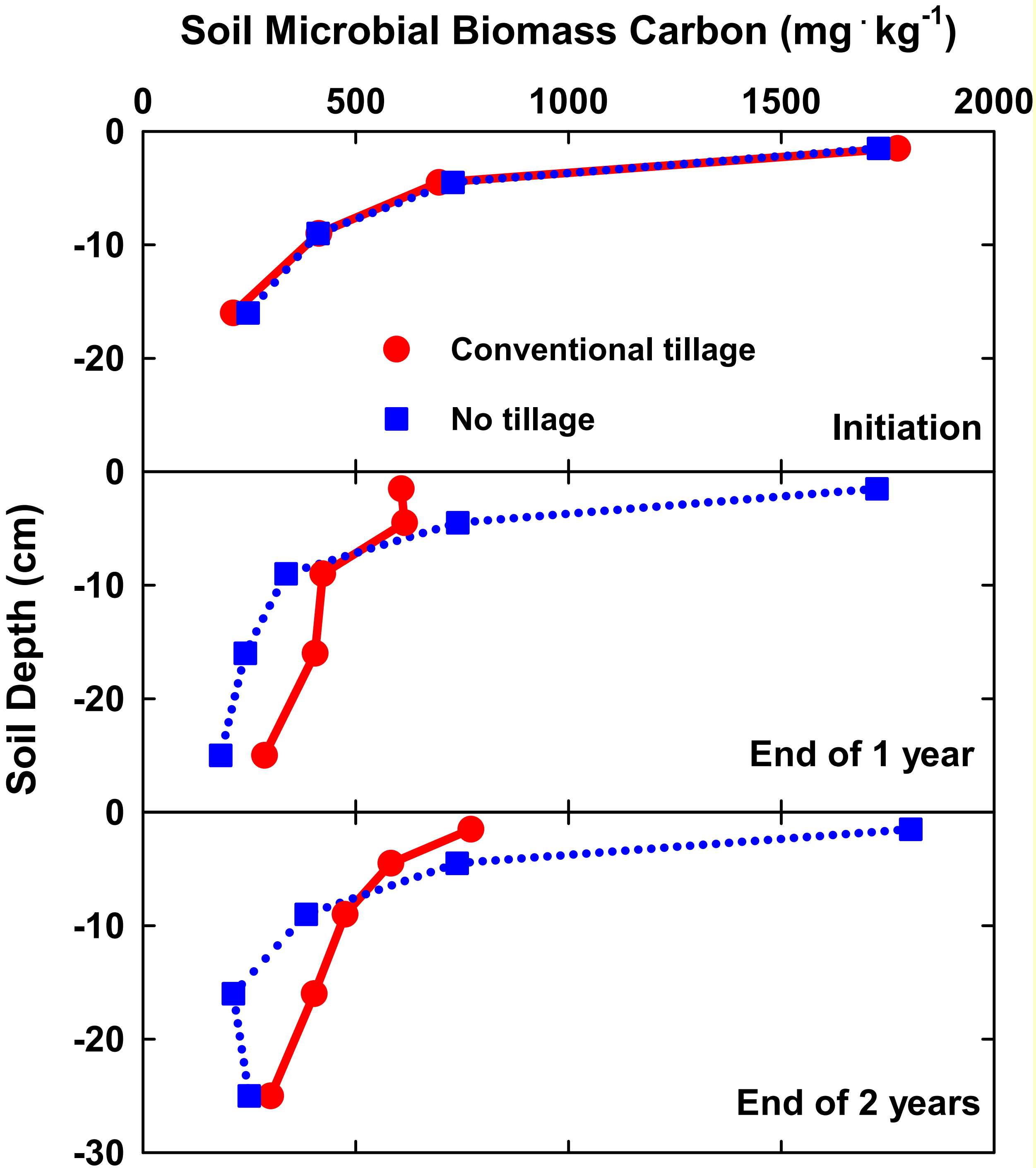


Results

Initially high surface C

Following moldboard-plow tillage, soil organic C became relatively uniformly distributed with depth

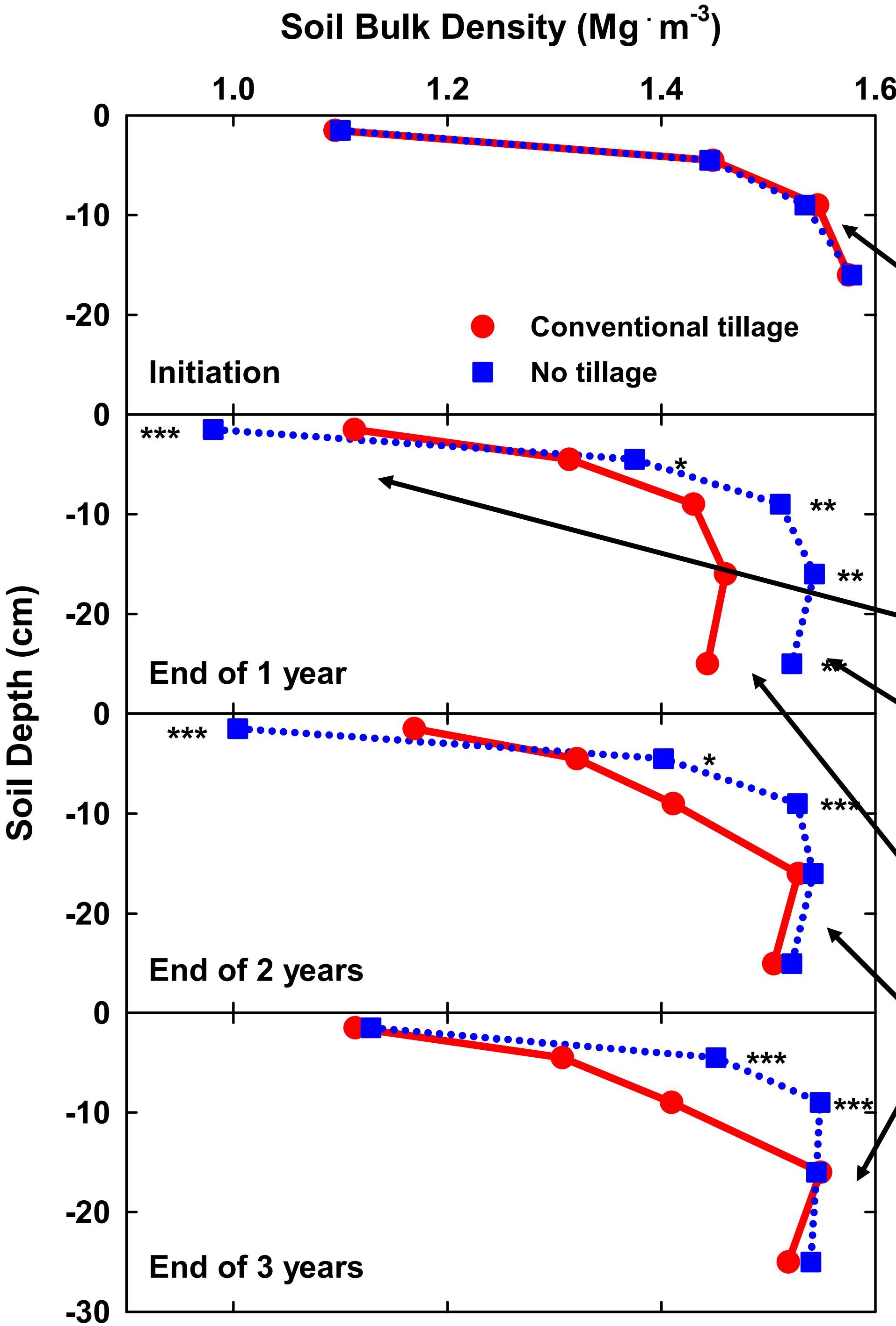
Soil organic C with NT was greater than with CT in the surface 6 cm, but lower than with CT below 12 cm



Results

Soil microbial biomass C followed a similar pattern as for total organic C.

Relatively uniform distribution with depth under CT and maintenance of stratified distribution with NT.



Results

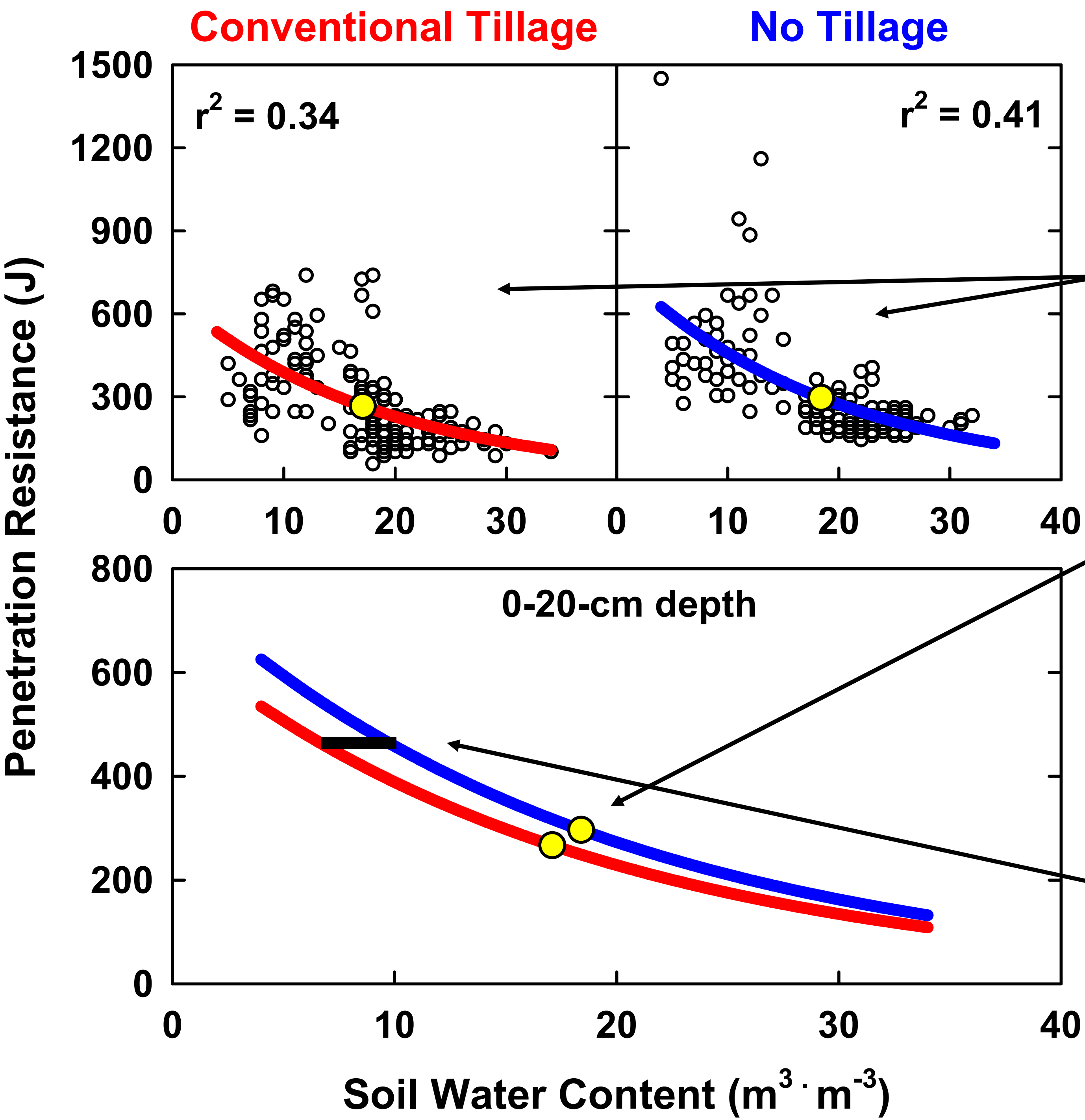
Initially low surface bulk density (BD) with rapidly increasing BD with depth

Soil under NT remained highly stratified with depth

- Low BD at the soil surface
- High BD > 6 cm

Moldboard plowing loosened soil initially following tillage

- However, after the first year, BD returned to a high level below 12 cm because of switch to shallow disk tillage



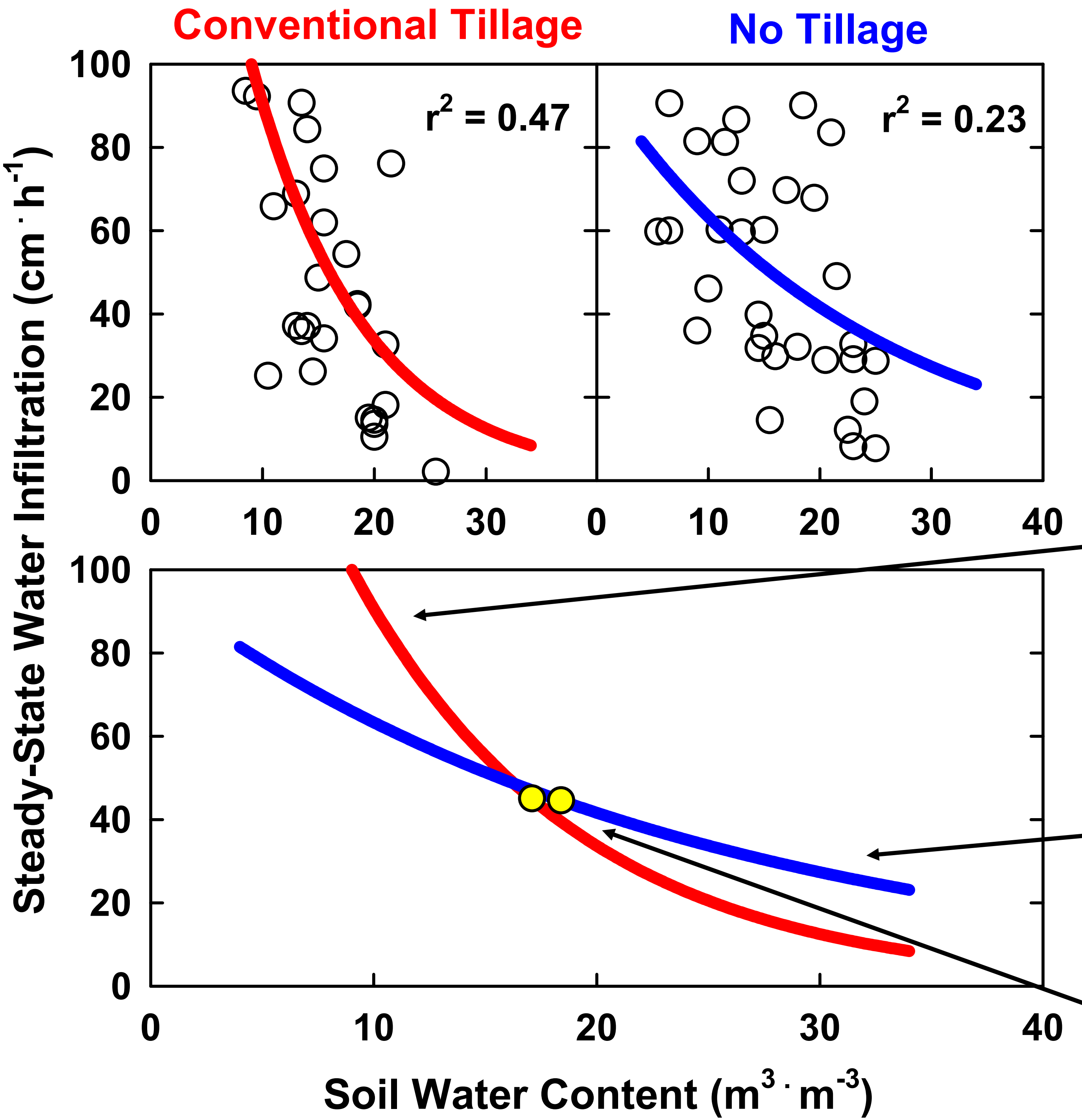
Results

Penetration resistance (PR) was highly related to antecedent soil water content.

Soil water content averaged:
CT = 17.1%
NT = 18.4%

PR was: NT > CT especially when dry

To achieve equal PR, soil water content would have to be 3% higher under NT.



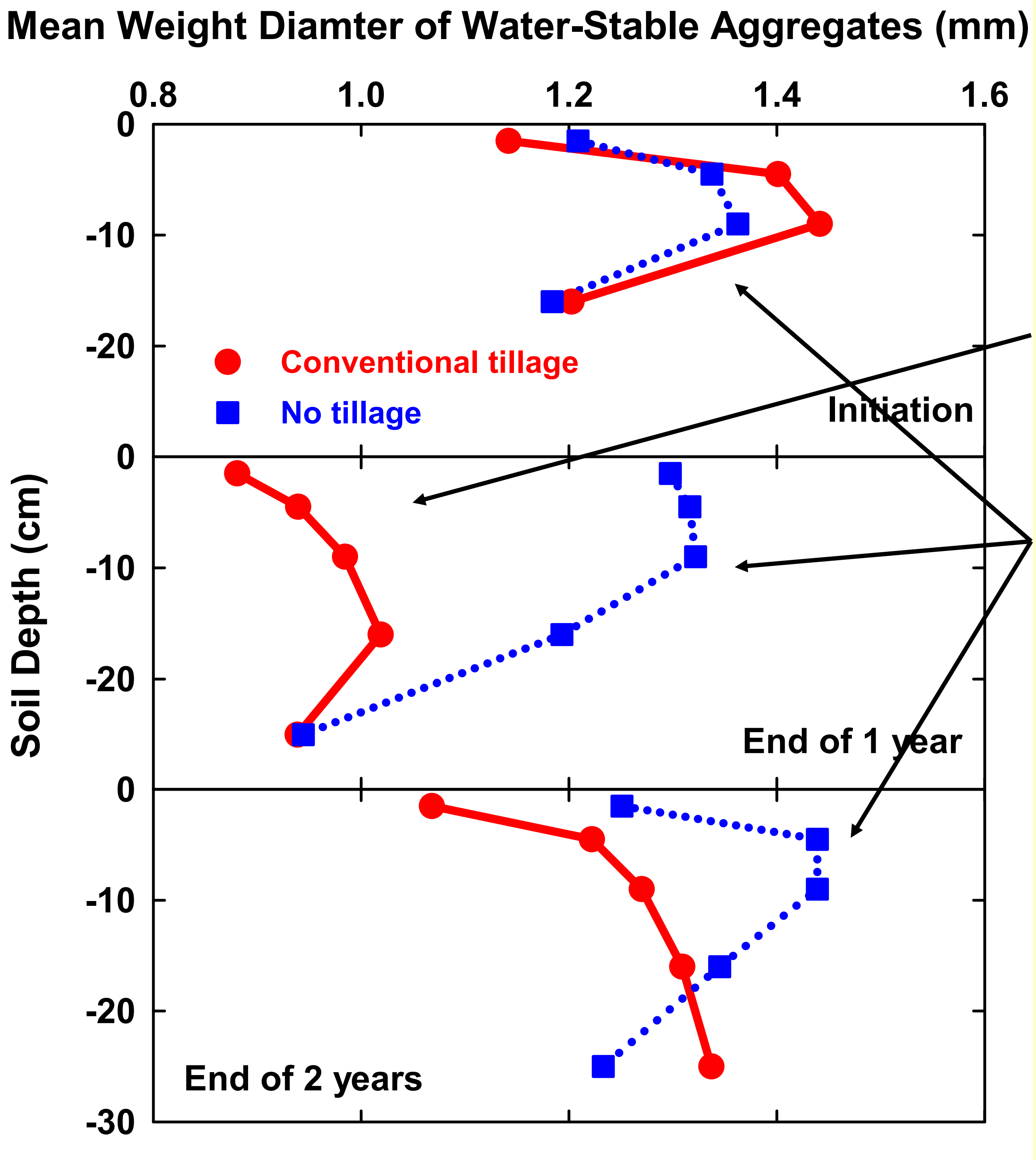
Results

Water infiltration was also highly related to antecedent soil water content.

At low water content, infiltration was:
CT > NT
Likely due to large pores from tillage.

With wetter soil, infiltration was:
NT > CT
likely due to connected pores.

At average water content, infiltration was: NT = CT



Results

Water-stable aggregates became smaller following plow tillage the first year.

Soil under NT maintained aggregate size with time similar to that at termination of the perennial pasture.

Smaller and less stable aggregates would lead to surface degradation (low soil organic C, low water infiltration, crusting).

Conclusions

- ✓ No tillage preserved the stratified nature of soil organic C and microbial biomass C following long-term pasture, which helped preserve larger water-stable aggregates.

- ✓ Conventional tillage temporarily loosened soil, reduced soil strength, and improved water infiltration under dry conditions, but not under wet conditions.

- ✓ Both conventional- and no-tillage strategies have advantages and disadvantages for the soil in the short-term, however the balance may change in longer-term evaluations.

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